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The introduced vegetation in the vicinity of Douglas Lake, Michigan*

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Throughout the eastern states the number of introduced species is one of the most remarkable features of the flora. These plants, originating in widely separated regions, are unusually well fitted by their habits of growth, by their physiological demands, by the amount of seed which they produce, or by the nature of their dissemination to exist in the immediate proximity of civilization. An increasing density of population, up to certain limits, merely creates new habitats for them, extends their old ones, or facilitates their seed dispersal. Most of them are unable to compete with native species, except when favored by human operations, and are not found far beyond cultivated ground. In this they differ radically from native plants, which rapidly decrease in number of species under the influence of civilization, so that there are in the eastern states very few species of native weeds.

The extensive areas of unsettled land in the vicinity of the biological station of the University of Michigan afford a good opportunity for the study of the distribution and behavior of the foreign species, and some of the results of this study are here presented.

Douglas Lake, just south of the Straits of Mackinac, lies in a gently rolling country of glacial origin. Most of the land to the south, west, and east of the lake is sand, and formerly supported a magnificent growth of white and Norway pines. This was lumbered about thirty years ago and no virgin area of pine forest now exists in the region. The pine land has been burned over repeatedly, and is now occupied by a sparse growth of aspens, *Populus grandidentata* predominating, mixed with various other species in smaller proportion. Practically none of this land is actually under cultivation.

North of the lake some morainic ridges rise high above the

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surrounding country, and the soil is of clay or of sand well mixed with humus. Both soil types were occupied with a dense forest of hardwoods, chiefly *Fagus grandifolia* and *Acer saccharum*, with a good mixture of *Tsuga canadensis*. Most of this has been lumbered within the past five years, and only small untouched areas are now remaining. Besides these two predominating types of vegetation, there are some rather extensive swamps with a dense growth of *Thuja occidentalis*, smaller tamarack and sphagnum bogs, and the usual small areas of marsh and dune vegetation along the shore of the lake. A full account of these has been published by Gates.*

On the north shore of the lake are some small and scattered farms, separated by woods or slashings, and several summer cottages. On the south side of the lake is one small summer resort, with about half a dozen cottages and the biological station and engineering camp of the University of Michigan. Otherwise the shore and immediate vicinity of the lake are uninhabited.

The known flora of the Douglas Lake region includes over 650 species of flowering plants and ferns. These species have been collected not merely over the unsettled area adjacent to the lake, but also from the settlements, extending in some directions as far as six miles away from the lake. Of these 650 species, 94 are considered as introduced into the Manual range by Robinson and Fernald in the seventh edition of Gray's Manual. Seventeen other species, considered to be native by these authors, are undoubtedly introduced into the Douglas Lake region. These are *Panicum capillare*, *Agrostis alba*, *Poa pratensis*, *Hordeum jubatum*, *Polygonum aviculare*, *Polygonum erectum*, *Amaranthus blitoides*, *Amaranthus graecizans*, *Euphorbia maculata*, *Euphorbia hirsuta*, *Verbena bracteosa*, *Plantago major*, *Silphium laciniatum*, *Silphium terebinthinaceum*, *Iva xanthifolia*, *Ambrosia psilostachya*, and *Helianthus annuus*. Nine other species are probably introduced, although the evidence is by no means certain. These are *Humulus Lupulus*, *Chenopodium hybridum*, *Lepidium virginicum*, *Lepidium apetalum*, *Lappula deflexa*, *Ambrosia artemisiifolia*, *Rudbeckia hirta*, *Achillea Millefolium*, and *Artemisia ludoviciana*.

* Frank C. Gates, The vegetation of the region in the vicinity of Douglas Lake, Cheboygan County, Michigan, 1911. 14th Rep. Mich. Acad. Sci. 46–106. *pl. v–xxib.* 1913.

The total number of introduced species is then apparently 120, or 18 per cent. of the total flora. This corresponds very closely to the proportion for the whole Manual range, which is 19 per cent., according to the tabulation in the seventh edition of the Manual. The systematic distribution of the 120 species is quite interesting, and differs markedly from that of the introduced flora of the whole Manual range. Among them are 24 composites, 16 grasses, 10 mints, 10 legumes, 9 mustards, 9 pinks, and 8 polygonads. These seven families include therefore nearly three quarters of the whole. The first two families contribute also about 76 native species to the flora of the region, but the last five are represented here chiefly by their 46 introduced species, and have but 31 native members in the known flora. For each of these seven families, the proportion of introduced species is considerably in excess of the general proportion for the Manual range. Of the pinks, 87 per cent. are introduced, compared with 47 per cent. in the Manual range, while for the other families the proportions are for the legumes 78 per cent., crucifers 53 per cent., polygonads 53 per cent., mints 47 per cent., composites 36 per cent., and grasses 34 per cent., compared with 20 per cent., 45 per cent., 24 per cent., 35 per cent., 17 per cent., and 17 per cent., respectively, for the Manual region as a whole. No definite reason can be assigned for the unusually large proportion of introduced species in these particular families, but it may be possible that the Douglas Lake region lies too far north for most of the native species.

Of these 120 species, a considerable number have been found only in the immediate vicinity of civilization and at a considerable distance from Douglas Lake. The railroad tracks and vacant lots at Pellston have furnished a number, and several more species have escaped from cultivation in the thickly settled neighborhoods east of the lake. These plants have shown no tendency to establish themselves in the uncultivated region, or to follow the progress of civilization into it, and will accordingly receive no further attention in this paper.

For convenience, the introduced flora will be considered under three heads, that of summer resorts, of roads and clearings in the hardwoods, and of roads and clearings in the aspen land.

THE INTRODUCED FLORA NEAR SUMMER RESORTS

At Ingliside, at the northwest corner of the lake, are two permanent residences and several summer cottages. A wagon road leads to Levering, about five miles away, and is well travelled. Very few farming operations are under way in the vicinity, and the introduced species are practically confined to dooryards and kitchen gardens. The whole settlement occupies not to exceed six acres, and the following introduced species occur:

Poa compressa
Poa pratensis
Agrostis alba
Phleum pratense
Setaria viridis
Agropyron repens
Bromus secalinus
Rumex elongatus
Polygonum aviculare
Polygonum Persicaria
Polygonum Convolvulus
Chenopodium album
Amaranthus retroflexus
Arenaria serpyllifolia
Cerastium vulgatum
Silene noctiflora
Lychnis alba
Lepidium virginicum
Capsella Bursa-pastoris
Sisymbrium altissimum
Sisymbrium officinale var. *leiocarpum*
Brassica arvensis
Sedum acre
Trifolium repens
Trifolium pratense
Trifolium hybridum
Euphorbia Cyparissias
Malva rotundifolia
Cynoglossum officinale
Lappula deflexa
Solanum nigrum
Verbascum Thapsus
Nepeta Cataria
Plantago major
Plantago lanceolata
Ambrosia artemisiifolia
Iva xanthifolia
Anthemis Cotula
Achillea Millefolium
Chrysanthemum Balsamitae var. *tanacetoides*
Arctium minus
Taraxacum officinale

Of these 42 species, three are obviously escaped from cultivation, *Euphorbia Cyparissias*, *Sedum acre*, and *Chrysanthemum Balsamitae* var. *tanacetoides*.

About half a mile east of Ingliside along the lake shore is another summer colony of four cottages, located in a gravelly pastured field. The occupants reach their cottages chiefly by boat from Ingliside, thus reducing the opportunity for the chance introduction of plants. Here the introduced flora is composed of the following 26 species:

Poa pratensis
Poa compressa
Phleum pratense
Agrostis alba
Setaria viridis
Rumex Acetosella
Rumex elongatus
Polygonum Convolvulus
Arenaria serpyllifolia
Silene noctiflora
Sisymbrium altissimum
Sisymbrium officinale var. *leiocarpum*
Capsella Bursa-pastoris
Trifolium repens
Trifolium pratense
Trifolium hybridum
Lappula deflexa
Cynoglossum officinale
Verbascum Thapsus
Nepeta Cataria
Plantago major
Plantago lanceolata
Chrysanthemum Leucanthemum var. *pinnatifidum*
Cirsium lanceolatum
Taraxacum officinale
Lepidium virginicum

About half a mile beyond this settlement, or a mile from Ingliside, is the most remote of the summer settlements, consisting here of but two cottages. They are located in a hardwood forest and have practically no cleared land around them. Here there is no introduced flora whatever, although some daisies planted around a veranda show a slight tendency to spread. Just behind these cottages along an abandoned logging road nineteen species of introduced plants occur.

These data, showing the reduction in the introduced flora from 42 species to none in a distance of a mile, indicate clearly the inability of the species to migrate without some effective human aid. The same feature is illustrated by the flora around or near Bryant's hotel, on the south side of the lake. Here is a wagon road from Pellston, and during the summer months the travel is quite heavy. All vehicles stop at or near the hotel, and persons desiring to reach the farther cottages walk down the beach. In the immediate vicinity of the hotel nineteen species occur. These are:

Poa compressa
Poa pratensis
Poa annua
Agrostis alba
Phleum pratense
Polygonum aviculare
Polygonum Persicaria
Polygonum Convolvulus
Rumex elongatus
Rumex Acetosella
Chenopodium album
Chenopodium hybridum

Amaranthus retroflexus
Lepidium virginicum
Malva rotundifolia
Nepeta Cataria
Plantago major
Anthemis Cotula
Taraxacum officinale

In the dooryards of the cottages just beyond the hotel the number is reduced to thirteen:

Poa compressa
Poa pratensis
Agrostis alba
Phleum pratense
Rumex elongatus
Rumex Acetosella
Chenopodium album
Cerastium vulgatum
Trifolium repens
Trifolium hybridum
Verbascum Thapsus
Achillea Millefolium
Taraxacum officinale

In the dooryards of the three cottages farthest from the hotel the number of species is reduced to seven only:

Poa pratensis
Poa compressa
Agrostis alba
Rumex elongatus
Verbascum Thapsus
Achillea Millefolium
Taraxacum officinale

A quarter of a mile farther, in the small clearing around an abandoned Indian hut, *Dianthus barbatus* is escaped from cultivation, and fourteen introduced species occur. All of these are found also in the vicinity of the hotel, except *Capsella Bursa-pastoris* and *Trifolium pratense.*

Around the premises of the biological station a few species of introduced plants occur, but so far as known only one of them has been introduced since the opening of the station in 1909. The station occupies the site of a logging camp abandoned many years before, and the introduced flora is probably a relic of that time. Besides the species listed below, a solitary plant of *Satureja Acinos* was found in 1912, and young plants from its seeds were found again in 1914. It was probably introduced in packing material.

Poa compressa
Poa pratensis
Agrostis alba
Phleum pratense
Avena sativa
Secale cereale
Agropyron repens
Setaria viridis
Rumex Acetosella
Rumex elongatus

Polygonum Convolvulus	*Brassica arvensis*
Chenopodium album	*Trifolium pratense*
Silene noctiflora	*Verbascum Thapsus*
Cerastium vulgatum	*Achillea Millefolium*
Lepidium virginicum	*Taraxacum officinale*
Capsella Bursa-pastoris	

One interesting colony of introduced plants is found in a small clearing occupying a somewhat elevated spot in the midst of a cedar swamp. An old man has lived there alone for several years, but the clearing contained no introduced species until two years ago. At that time a small summer cottage was built there, and the new additions to the flora were probably brought in in packing material. At least most of them are found immediately in front of the door, where any goods would probably be unpacked. An area not more than a hundred feet in diameter contains 24 species. Most of them are found around other clearings also, but among them are a few not known to occur elsewhere in the uncultivated region. These are:

Salsola Kali	*Portulaca oleracea*
var. *tenuifolia*	*Solanum nigrum*
Amaranthus blitoides	*Sonchus asper*

These data summarized indicate that not to exceed 56 species out of 120 have succeeded in establishing themselves in the vicinity of the remote dwellings in this uncultivated region, and that the largest settlement, with two houses permanently occupied, supports 42 of these.

THE INTRODUCED FLORA OF HARDWOOD CLEARINGS

Near the northeastern end of Douglas Lake a large tract of beech-maple-hemlock hardwoods was lumbered in the winter of 1910–11 and has been left undisturbed since. During the last three years the usual clearing vegetation has developed, consisting at first of *Epilobium angustifolium*, *Erigeron canadensis*, and *Erechtites hieracifolia*, followed by a tangle of *Sambucus racemosa*, *Rubus idaeus* var. *aculeatissimus*, and young beech and maple saplings. Within this dense vegetation no introduced species is found. At intervals small cleared spots, seldom more than twenty feet across, mark places where horses were fed or lunches eaten

during the logging operations. Each of these shelters from four to twelve introduced species, as follows:

Poa pratensis
Phleum pratense
Agrostis alba
Rumex Acetosella
Polygonum Convolvulus
Chenopodium album
Lepidium virginicum
Capsella Bursa-pastoris
Trifolium repens
Trifolium hybridum
Lappula deflexa
Cynoglossum officinale
Verbascum Thapsus
Cirsium lanceolatum
Cirsium arvense
Taraxacum officinale

The chief logging road leading from this tract is nearly overgrown with thickets, but is still marked by numerous introduced species. These include every one of the preceding list and the following in addition:

Poa compressa
Rumex elongatus
Lychnis alba
Trifolium pratense
Chrysanthemum Leucanthemum var. *pinnatifidum*

Mention has already been made of the fact that nineteen introduced species occur along a road in another part of the hardwood region. Among these are four not mentioned above, *Cerastium vulgatum*, *Silene noctiflora*, *Nepeta Cataria*, and *Plantago major*.

West of Bryant's hotel there formerly stood a grove of hardwood, lumbered in the winter of 1912–13. Observations of the flora made in 1911 showed one introduced species, *Cirsium lanceolatum*, while in 1912 no introduced species was seen. At the present time 29 such species occur along the principal road through it, leading from Pellston to Bryant's hotel. These are:

Poa compressa
Poa pratensis
Phleum pratense
Agropyron repens
Secale cereale
Agrostis alba
Rumex elongatus
Rumex Acetosella
Polygonum aviculare
Polygonum Persicaria
Polygonum Convolvulus
Chenopodium album
Cerastium vulgatum
Silene noctiflora
Lepidium virginicum
Sisymbrium altissimum
Trifolium repens
Trifolium pratense
Trifolium hybridum
Lappula deflexa

Solanum nigrum
Verbascum Thapsus
Nepeta Cataria
Plantago major
Achillea Millefolium
Chrysanthemum Leucanthemum var. *pinnatifidum*
Cirsium lanceolatum
Cirsium arvense
Taraxacum officinale

Back of this road in soil exactly the same, and like the road covered until two years ago with a dense forest, there is now a tangle of brush heaps, with a dense growth of *Epilobium angustifolium* and young maple seedlings. In it the eleven introduced species are strictly confined to small open places and feeding grounds, and are exceedingly few in number of individuals. The following occur:

Poa pratensis
Phleum pratense
Rumex Acetosella
Polygonum Convolvulus
Chenopodium album
Trifolium repens
Trifolium hybridum
Solanum nigrum
Verbascum Thapsus
Cirsium lanceolatum
Taraxacum officinale

In all, only 26 species have been observed in areas formerly occupied by hardwoods, and these are in every case confined to the logging roads and feeding grounds. This does not include seven other species growing along the public road near Bryant's hotel.

THE INTRODUCED VEGETATION IN THE ASPEN REGION

As in other types of vegetation, the introduced species among the aspens are again almost confined to the immediate vicinity of the roads. In this case, quantitative studies of their distribution were made by the quadrat method. In one hundred places chosen at random, a strip of 2-meter quadrats was observed. These were so placed that the first quadrat was adjacent to the wagon track of the main road through the aspens, and the others extended in a strip perpendicular to the roadway. Observations were continued on each strip until two successive quadrats showed no introduced species whatever. In most cases no introduced plants were found beyond the fifth quadrat, and in no case was one found beyond the tenth. This indicates that in the thirty years since the pines were lumbered, introduced species have been

able to penetrate, in general, less than twenty meters into the aspen thickets. Even yet they are most numerous in the quadrats nearest the roadway, as shown by the following table, in which the data for the one hundred series have been collected. The first figure after each species indicates the number of *first* quadrats in which it occurs, the second figure the number of *second* quadrats, and so on.

	1	2	3	4	5	6	7	8	9	10
Poa compressa	65	40	29	29	17	11	4	2	1	
Poa pratensis	63	28	27	20	15	7	4	2		
Agrostis alba	59	10	8	8	10	3			1	
Phleum pratense	40	4	9	4	6	3	2			
Trifolium repens	21	15	5	7	6	5	4	2	2	
Trifolium pratense	16	7	7	3	2	5	3		1	
Rumex Acetosella	13	9	18	25	25	24	10	4	5	1
Agropyron repens	13	6	8	2	3	2	2			
Trifolium hybridum	9	1	1	1						
Lepidium virginicum	5	3	2	2		1	1	1		
Dactylis glomerata	3	1								
Taraxacum officinale	1			1						
Chrysanthemum Leucanthemum var. *pinnatifidum*	1									
Verbascum Thapsus				2	3			1		
Total	309	124	114	104	87	61	30	12	10	1

These figures clearly indicate the close dependence of the introduced species upon human operations. Besides these fourteen species, *Avena sativa*, *Polygonum aviculare*, *Cerastium vulgatum*, and *Achillea Millefolium* also occur in the same association.

A deep ravine traverses a part of the aspen region, and some springs at its bottom make it a favorite camp ground and watering place for horses. In the small flat clearing at the bottom of this ravine fourteen introduced species occur, including besides those listed above *Secale cereale*, *Arenaria serpyllifolia*, and *Cirsium lanceolatum*. In all, 21 introduced species are known to occur in the aspen region.

Only three species of the introduced group are apparently establishing themselves in the aspen association, in spite of the open vegetation and the abundant space available for plants. Of these the most successful is *Rumex Acetosella*, now found widely scattered throughout the association, with a frequency index of from 10 to 15. *Lepidium virginicum* is common along most roadsides, and in some places these colonies occur away from the

roads, giving the species in some parts of the aspen association a frequency index of 2 or 3. *Verbascum Thapsus* occurs in scattered patches, usually grouped around a single plant of the previous year. The year 1914 has apparently been unusually favorable for this species, since many more such patches occur than ever before.

The close dependence of all the introduced species upon cultivation is well shown at the edge of the uncultivated area, and may be illustrated here by data from the margin of the aspen association east of Douglas Lake. A field planted to rye in 1913 stood idle in 1914, and was well overgrown with various species of weeds. It is separated by a wire fence from the uncultivated land to the west. A strip of fifteen 2-meter quadrats, extending from the fence into the field, was counted, and showed a total of 21 species. Of these fourteen were introduced, with an average frequency index of 44, and seven were native, with an average frequency of 31. The field on the other side of the fence is well grown up with thickets of oak and aspen, but has been pastured and supports a good bluegrass sod. A similar list of quadrats showed in it sixteen species, of which only three were introduced, *Poa pratensis*, *Verbascum Thapsus*, and *Taraxacum officinale*.

CONCLUSIONS

1. Of 120 introduced species in the region, only 56 have been observed within the uncultivated region. All of these occur in the vicinity of dwellings; 26 along recent logging roads or camp grounds in the hardwood region; 21 along roads or camp grounds among the aspens; and only three show a tendency to establish themselves among the native species.

2. The great reduction in the number of introduced species around the more remote settlements shows that they are in many cases dependent upon human aid for their dispersal.

3. Among these 56 species are many with efficient means of dispersal. Their limitation to the immediate vicinity of roads, camp grounds, or dwellings is accordingly due, not to lack of mobility, but to inability to compete successfully with the native species.